Solution 11.1

$-\sin\alpha = \sin(\alpha-180^\circ) = \sin(\alpha+180^\circ)$

& $\sin\alpha = \cos(\alpha-90^\circ)$

$$v(t) = 160\cos(50t)\ \text{V}$$

$$i(t) = -33\sin(50t-30^\circ)\ \text{A} = 33\cos(50t-30^\circ+180^\circ-90^\circ) = 33\cos(50t+60^\circ)$$

$$p(t) = v(t)i(t) = 160\text{x}33\cos(50t)\cos(50t+60^\circ) \Longrightarrow \cos\alpha\cos\beta = \tfrac{1}{2}\left[\cos(\alpha+\beta)+\cos(\alpha-\beta)\right]$$

$$= 5280(1/2)[\cos(100t+60^\circ)+\cos(60^\circ)] = \mathbf{[\underbrace{1.320}_{P_{avg}}+\underbrace{2.640\cos(100t+60^\circ)}_{\text{time varying}}]\ kW}.$$

$$P = [V_m I_m/2]\cos(0-60^\circ) = 0.5\text{x}160\text{x}33\text{x}0.5 = \mathbf{1.320\ kW}.$$

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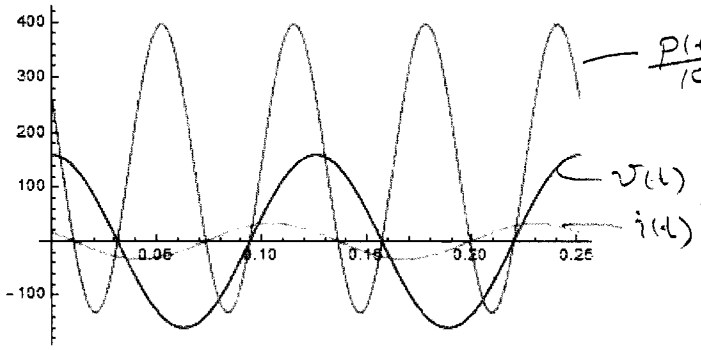
```
In[21]:= v[t_] := 160 * Cos[50 * t]
         i[t_] := -33 * Sin[50 * t - 30 * Pi / 180.]
         p[t_] := v[t] * i[t]

         Plot[{v[t], i[t], p[t] / 10}, {t, 0, 2 / (50 / (2. * Pi))}]
```

Out[24]=



: varies at 2·f of v(t) & i(t)

Solution 11.2

Given the circuit in Fig. 11.35, find the average power supplied or absorbed by each element.

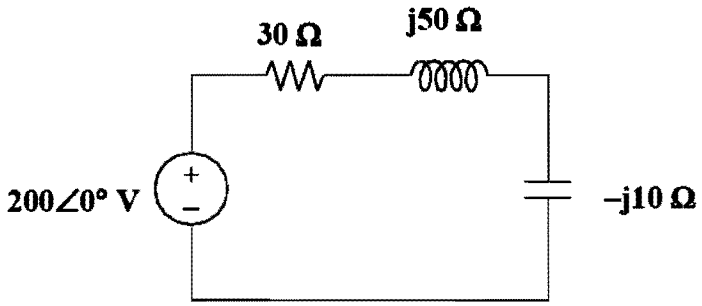
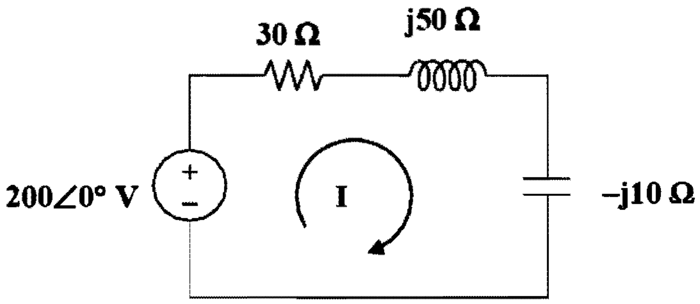


Figure 11.35
For Prob. 11.2.

Solution

Step 1. First we can write one mesh equation and solve for I. Once we have I, we can then find the average power absorbed by each element. Obviously the source will have a negative power absorbed meaning it is supplying power. One last comment, since we still have not covered rms values, we will treat the 200 V as a peak value.



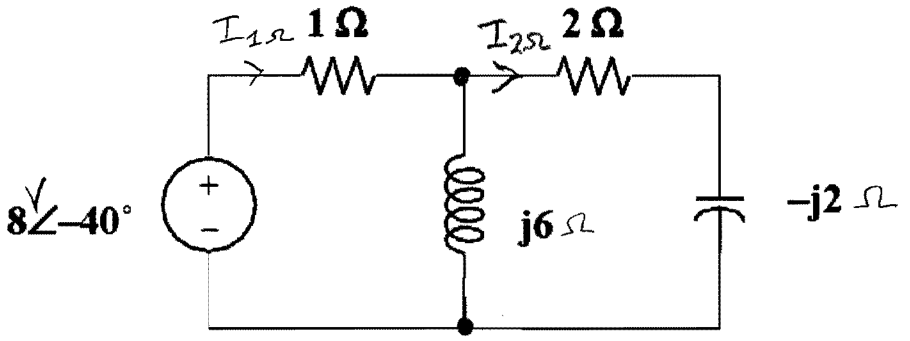
$-200 + 30\mathbf{I} + j50\mathbf{I} + (-j10)\mathbf{I} = 0$ or $\mathbf{I} = 200/(30+j40)$. Finally, $P_{30} = \mathbf{I}(\mathbf{I})^*30$, $P_{j50} = 0$, $P_{-j10} = 0$, and $P_{200} = -|\mathbf{V}|\ |\mathbf{I}|\cos(\theta)$

Step 2. $\mathbf{I} = 200/50\angle 53.13° = 4\angle{-53.13°}$ A. Thus,

$P_{30} =$ **480 W** and $P_{200} =$ **−480 W**.

Solution 11.5

Converting the circuit into the frequency domain, we get:



$$I_{1\Omega} = \frac{8\angle -40^\circ}{1 + \dfrac{j6(2-j2)}{j6+2-j2}} = 1.6828\angle -25.38^\circ$$

$$P_{1\Omega} = \frac{1.6828^2}{2} 1 = \underline{1.4159\text{ W}}$$

$P_{1\Omega}$ = 1.4159 W

$P_{3H} = P_{0.25F}$ = 0 W

current division

$$|I_{2\Omega}| = \left| \frac{j6}{j6+2-j2} 1.6828\angle -25.38^\circ \right| = 2.258$$

$$P_{2\Omega} = \frac{2.258^2}{2} 2 = \underline{5.097\text{ W}}$$

$P_{2\Omega}$ = 5.097 W

$\underline{P_{Avg,8V}} = \frac{1}{2}Re[\bar{V}\cdot\bar{I}^*] = \frac{1}{2}Re[8\angle -40^\circ \cdot 1.6828\angle 25.38^\circ] = \frac{1}{2}Re[13.027 - j3.398]$
$= \underline{6.513\text{ W}}$

$\underline{P_{1\Omega} + P_{2\Omega}} = 1.4159 + 5.097 = 6.513\text{ W}$

Time averaged power supplied / dissipated

Solution 11.11

$$Z_{ab} = \frac{R}{\sqrt{1+\omega^2R^2C^2}} \angle -\tan^{-1}(\omega RC)$$

$$i(t) = 33\sin(\underbrace{377}_{=\omega}t + 22°)\ mA$$

$\omega = 377$ rad/s $\quad R = 10^4\ \Omega \quad C = 200\times10^{-9}$ F

$\omega RC = (377)(10^4)(200\times10^{-9}) = 0.754$

$\tan^{-1}(\omega RC) = 37.02°$

$$Z_{ab} = \frac{10k}{\sqrt{1+(0.754)^2}}\angle -37.02° = 7.985\angle -37.02°\ k\Omega$$

$i(t) = 33\sin(377t + 22°) = 33\cos(377t - 68°)\ mA$

$\mathbf{I} = 33\angle{-68°}$ mA

$$S = \frac{I^2 Z_{ab}}{2} = \frac{(33x10^{-3})^2(7.985\angle -37.02°)\times10^3}{2}$$

$\mathbf{S} = 4.348\angle{-37.02°}$ mVA

$P = |S|\cos(37.02) = \mathbf{3.472}$ ~~**W**~~ mW

(or $P = \frac{1}{2}Re[\bar{V}\bar{I}^*] = \frac{1}{2}Re[\bar{I}\cdot\bar{Z}\cdot\bar{I}^*] = \frac{1}{2}Re[|\bar{I}|^2\cdot\bar{Z}]$

$= \frac{|\bar{I}|^2}{2}\cdot Re[\bar{Z}] = \frac{I^2}{2}Re[\bar{Z}]$

$\therefore P = \frac{(33\times10^{-3})^2}{2}\cdot Re[Z_{ab}] = \frac{(33\times10^{-3})^2}{2}\cdot Re[6375 - j\,4.808]$

$\underline{P = 3.471\ mW}$)